

What is claimed is:

1. A heat transfer system which comprises:
 - a hollow supply tube having a proximal end and a distal end;
 - a capillary tube having a proximal end and a distal end with the
5 proximal end thereof connected in fluid communication with the distal
end of said supply tube, said capillary tube being formed with a lumen
having a length "l" and a diameter "d";
 - a tip member positioned to surround the distal end of said
capillary tube to create a cryo-chamber therebetween; and
 - 10 a source of refrigerant fluid connected in fluid communication
with the proximal end of the supply tube to introduce the refrigerant
fluid into the supply tube at a working pressure " p_w " for transfer of the
refrigerant fluid through said supply tube and through said capillary
tube for exit from the distal end of said capillary tube and into said cryo-
15 chamber in a substantially liquid state for transition of the refrigerant
fluid into a gaseous state with a tip pressure " p_t " and a tip temperature
" t_t " for heat transfer through said tip member and into the gaseous fluid
refrigerant in said cryo-chamber.
2. A system as recited in claim 1 wherein said supply tube is
20 formed with a lumen having a length " l_s " and a diameter " d_s ", and wherein the
diameter of the lumen of said capillary tube "d" is less than the diameter " d_s "
and " l_s " is less than or equal to the length "l".
3. A system as recited in claim 1 wherein an aspect ratio " d/l " for
the capillary tube is in a range of 0.0008 to 0.0017.
- 25 4. A system as recited in claim 3 wherein the length "l" of said
capillary tube is in a range between approximately four and one half inches
and approximately ten inches.

5. A system as recited in claim 4 wherein the diameter “d” of said capillary tube is 0.008 inches.
6. A system as recited in claim 1 wherein the refrigerant fluid is nitrous oxide (N₂O).
- 5 7. A system as recited in claim 1 wherein the working pressure “p_w” is in a range between three hundred and fifty psia and five hundred psia.
8. A system as recited in claim 7 wherein the tip pressure “p_t” is less than one atmosphere.
9. A system as recited in claim 8 wherein the tip temperature “p_t” is
10 less than minus eighty four degrees Centigrade (p_t < -84°C).
10. A heat transfer system which comprises:
a means for providing a liquid refrigerant at a first pressure;
a means for reducing the pressure on the liquid refrigerant from the first pressure to a second pressure; and
15 a means for introducing the liquid refrigerant into a cryo-chamber at the second pressure for transition of the liquid refrigerant into a gaseous state in the cryo-chamber to cause heat to transfer from outside the cryo-chamber and into the cryo-chamber.

11. A system as recited in claim 10 wherein said reducing means comprises:
- a hollow supply tube having a proximal end and a distal end;
 - and
 - 5 a capillary tube having a proximal end and a distal end with the proximal end thereof connected in fluid communication with the distal end of said supply tube, said capillary tube being formed with a lumen having a length "l" and a diameter "d" wherein an aspect ratio "d/l" for the capillary tube is in a range of 0.0008 to 0.0017.
- 10 12. A system as recited in claim 11 wherein the length "l" of said capillary tube is in a range between approximately four and one half inches and approximately ten inches and the diameter "d" of said capillary tube is in a range between approximately 0.008 inches and approximately 0.010 inches.
- 15 13. A system as recited in claim 10 wherein the first pressure is a working pressure " p_w " in a range between three hundred and fifty psia and five hundred psia and the second pressure is a tip pressure " p_t " less than one atmosphere.
- 20 14. A system as recited in claim 13 wherein the refrigerant in the gaseous state in the cryo-chamber has a tip temperature " t_t " less than minus eighty four degrees Centigrade ($p_t < -84^\circ\text{C}$).
15. A system as recited in claim 10 wherein the liquid refrigerant is nitrous oxide (N_2O).

16. A method for transferring heat which comprises the steps of:
providing a liquid refrigerant at a first pressure;
reducing the pressure on the liquid refrigerant from the first
pressure to a second pressure; and
5 introducing the liquid refrigerant into a cryo-chamber at the
second pressure for transition of the liquid refrigerant into a gaseous
state in the cryo-chamber to cause a transfer of heat outside the cryo-
chamber and into the cryo-chamber.
17. A method as recited in claim 16 wherein said reducing step
10 comprises the steps of:
advancing the liquid refrigerant through a hollow supply tube to
a capillary tube having a proximal end and a distal end; and
causing the liquid refrigerant to flow through the lumen of the
capillary tube wherein the lumen of the capillary tube has a length "l"
15 and a diameter "d" with an aspect ratio "d/l" for the capillary tube in a
range of 0.0008 to 0.0017.
18. A method as recited in claim 17 wherein the length "l" of said
capillary tube is in a range between approximately four and one half inches
and approximately ten inches and the diameter "d" of said capillary tube is in a
20 range between approximately 0.008 inches and approximately 0.010 inches.
19. A method as recited in claim 16 wherein the first pressure is a
working pressure " p_w " in a range between three hundred and fifty psia and five
hundred psia and the second pressure is a tip pressure " p_t " less than one
atmosphere.

20. A method as recited in claim 16 wherein the liquid refrigerant is nitrous oxide (N_2O) and when in the gaseous state in the cryo-chamber has a tip temperature " t_t " less than minus eighty four degrees Centigrade ($p_t < -84^\circ\text{C}$).